Utah Department of Environmental Quality
Division of Water Quality
TMDL Section

Little Bear River Watershed TMDL

Waterbody ID	Little Bear River & Tributaries
Location	Cache County, Northern Utah
Pollutants of Concern	Total Phosphorus Hydrologic Modification
Impaired Beneficial Uses	Class 3A: Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
Loading Assessment	
1998-99 Load	
-Above Cutler	22 kg/day
- Above Hyrum	8.4 kg/day
TMDL Target Load	
- Above Cutler	9.0 kg/day
- Above Hyrum	6.0 kg/day
Load Reduction	
- Above Cutler	13 kg/day
- Above Hyrum	2.4 kg/day
Defined Targets/Endpoints	• 14 Animal Waste Mgt. Systems • 25% reduction of cropland runoff • 10 miles of streambank restoration • Not to exceed 0.05 mg/l total phosphorus concentration in stream • Install BMP's on 7500 acres designated as critical
Implementation Strategy	BMP's Animal Waste Mgt. Irrigation Water Mgt. Riparian Rehabilitation Nutrient Mgt. Streambank Stabilization Range/Pasture Mgt. Animal Waste Storage Facilities Point Source Control

This document is identified as a TMDL for Little Bear River and is officially submitted to the U.S. EPA to act upon and approve as a TMDL.

Little Bear River TMDL

I. Introduction

The Little Bear River Watershed is located in Cache County, Northern Utah. The watershed encompasses 182,000 acres and includes cropland, pasture, and rangeland. Land use is range/wildlife, irrigated land, dry cropland and other. Land ownership is 88% private, 10% national forest and 2% state land. The National Forest and state lands are used primarily for grazing and forest areas.

Land within the watershed is used primarily for livestock feed production, grazing and wildlife. There are about 21,024 acres of irrigated land within the watershed consisting of alfalfa, hay and pasture land, small grain, corn and some set aside, idle and miscellaneous crops. An additional 13,837 acres are used as non-irrigated cropland including alfalfa, small grain, and fallow.

The Little Bear River has two main drainages. The South Fork originates in the low elevation foothills of the Wellsville Mountains and the Bear River Range. The East Fork drains a relatively extensive area of National Forest land, and is stored in the upper basin behind Porcupine Reservoir. Porcupine Reservoir's outflow is regulated for irrigation and flood control. Only about two percent of the area above the confluence of the two rivers is agricultural. Below their confluence, about 40 percent is agricultural. The Little Bear River below Hyrum dam conveys mainly irrigation return flow in the summer, but may receive high flushing flows in the spring and early summer during runoff events. About 52 percent of the drainage below Hyrum Reservoir is in agricultural use.

A small area (approximately 14,600 acres) in the Southern portion of Cache Valley drains to Spring Creek, which enters the Little Bear just above Cutler Reservoir. Much of the runoff from Hyrum drains into this creek and the area is heavily used for agricultural activities. About 75 percent of the area is agricultural, of which 95 percent is irrigated. In addition, several agricultural related industries (feedlots, rendering plants, and meat packaging plants) are located within this drainage. The Southern Fork of Spring Creek receives the effluent from Hyrum's WWTP, a meat packing plant and a large feedlot operation. Effluent from a small trout farm enters the northern fork of Spring Creek.

The Spring Creek drainage is identified as a tributary to the Little Bear River, however, it does not connect to the Little Bear River until below the lowest monitoring sites at Mendon Road. Because of the unique problems associated with Spring Creek it will not be included in this TMDL but rather will have one developed for it separately. The confluence of the two streams is located between Mendon Road and the Valley View highway in the backwater from Cutler Reservoir. Information contained in this TMDL is included because the Local Workgroup considers it part of the Little Bear River Watershed.

The desired goal for the TMDL is to meet state water quality standards for the designated beneficial uses of the waterbody. In addition to meeting state standards target endpoints associated with the TMDL coincide with LBR HUA goals and objectives.

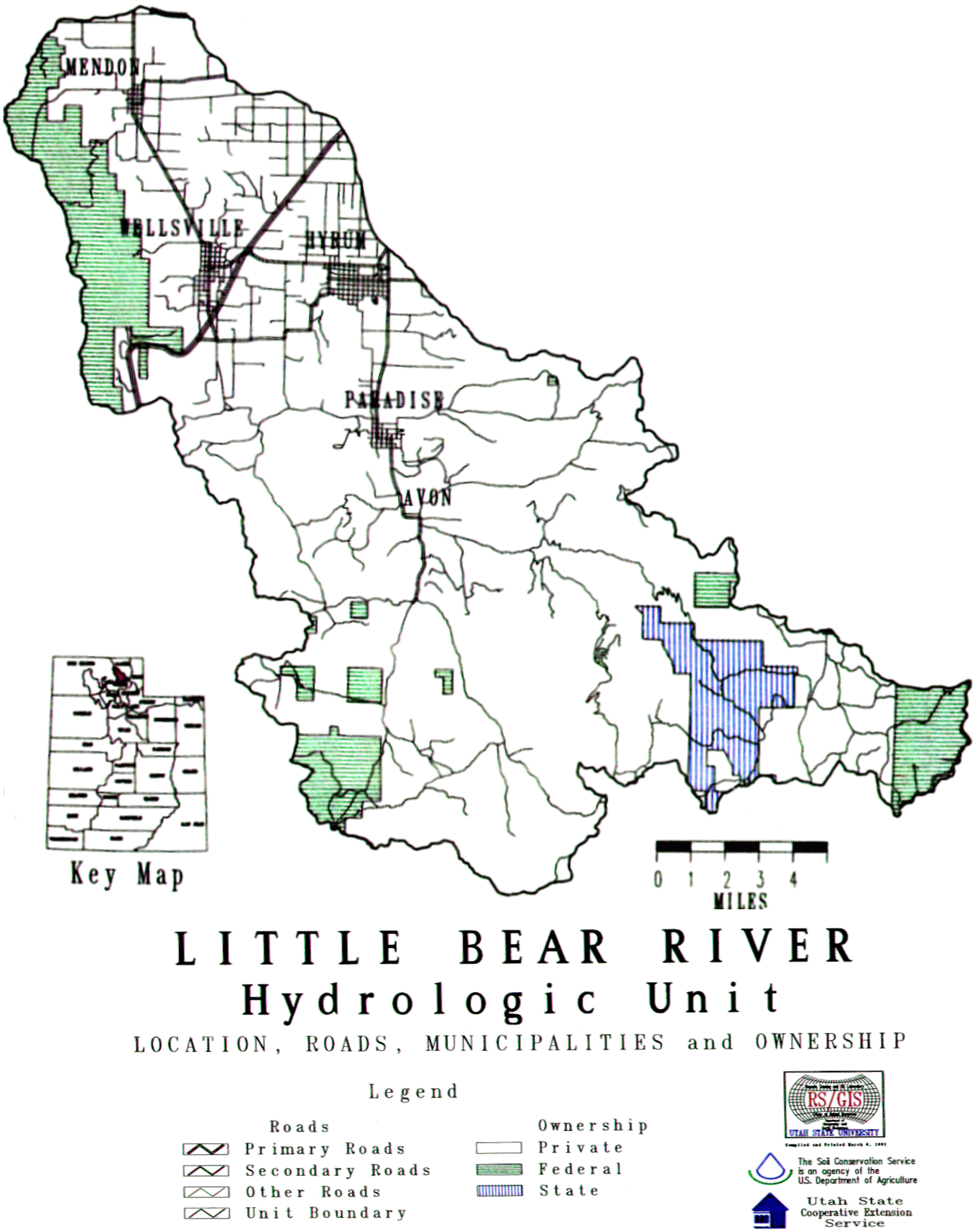

Figure 1 - Little Bear River Watershed / Land Ownership

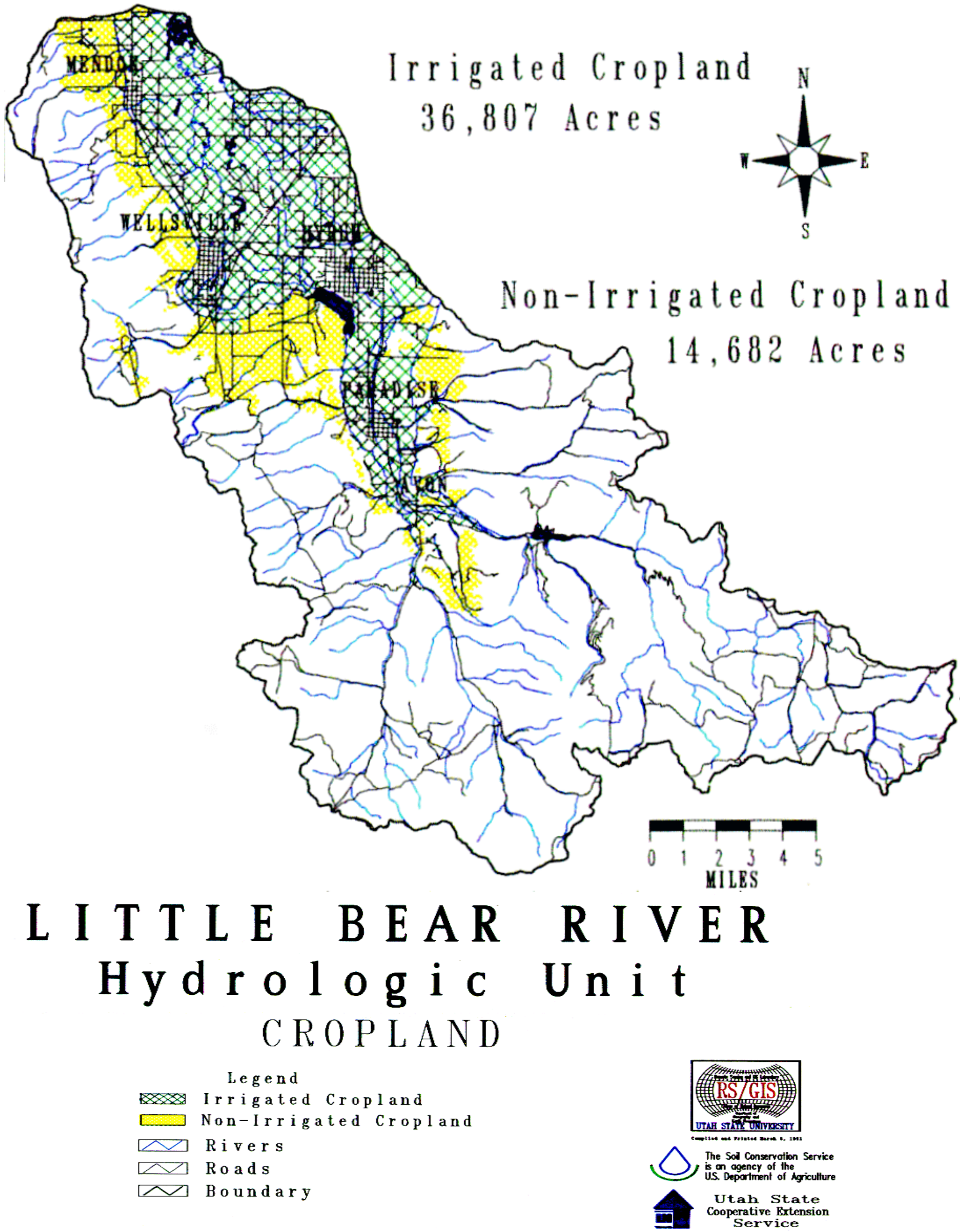

Figure 2 – Little Bear River Watershed / Cropland

II. Water Quality Standards

Water Quality standards are an important element of Utah's Water Quality Management Program because they set general and specific goals and requirements for the quality of our streams. Water quality standards consist of use designations, numeric standards, narrative standards, antidegradation policy and criteria necessary to protect the uses. Specific beneficial uses have been developed for all Utah surface waters. These uses were defined to protect existing stream uses. Specific numerical criteria were assigned to protect these beneficial uses.

Table 1 defines the designated beneficial use assigned to the Little Bear River, its tributaries and associated waterbodies. Table 2 defines all beneficial use classes for the state and their description.

Table 1 – Beneficial Use Classification of waterbodies in the Little Bear River Watershed.

Waterbody	**Beneficial Use Classification**
Little Bear River, Cutler Reservoir to Hyrum Reservoir and Hyrum Reservoir to East Fork confluence.	2B, 3A, 3D, 4
Spring Creek, confluence with Little Bear River to headwaters-including tributaries	2B, 3A, 3D, 4
Hyrum Reservoir	2A, 2B, 3A, 4
Cutler Reservoir	2B, 3B, 3D, 4

For additional information see 'Standards Of Quality for Waters Of The State' R317-2, Utah Administrative Code.

Public Law 92-500, the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act), enacted by Congress in 1972 and amended in 1977 and 1981, provides a national framework for water quality protection. The Clean Water Act recognizes that it is the primary responsibility of the States to prevent, reduce and eliminate water pollution; to determine appropriate uses for their waters and to set water quality criteria to protect those uses. Section 303(d) of the Clean Water Act requires that each state reviews and, if necessary, revises its Water Quality Standards at least once every three years. This serves to ensure that the requirements of state and federal law are met and that water quality criteria are adequate to protect designated water uses.

Several non-numeric standards also exist to protect water quality. The anti-degradation policy states that when water quality is better than the state standard, it should be maintained at that higher quality unless there are compelling economic or social reasons to allow it to deteriorate, although at no time may water quality deteriorate to below the water quality standard. Narrative standards written into the code further state that no discharges may be made, which would result in deteriorated conditions or would adversely affect desirable aquatic life.

Table 2 – State Beneficial Use Classification and Description

Class 1	**Protected for use as a raw water source for domestic water systems.**
	Class 1C: Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water.
Class 2	**Recreational use and aesthetic**
	Class 2A: Protected for primary contact recreation such as swimming.
	Class 2B: Protected for secondary contact recreation such as boating, wading, or similar uses.
Class 3	**Protected for use by aquatic wildlife.**
	Class 3A: Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
	Class 3B: Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
	Class 3C: Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.
	Class 3D: Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.
	Class 3E: Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.
Class 4	**Protected for agricultural uses including irrigation of crops and stock watering.**
Class 5	**The Great Salt Lake**. Protected for primary and secondary contact recreation, aquatic wildlife, and mineral extraction.

For additional information see 'Standards Of Quality for Waters Of The State' R317-2, Utah Administrative Code.

Utah's 303(d) list divides the Little Bear River into two segments. The first is Little Bear River from Cutler Reservoir to Hyrum Reservoir. This segment is 28.1 miles in length and is listed as impaired for class 3A with the specific pollutant or stressor as total phosphorus and hydrologic modification. The second segment is identified as Little Bear River from Hyrum Reservoir to East Fork Little Bear Confluence. This segment is 6.8 miles in length and is listed as impaired for class 3A with total phosphorus as the specific pollutant or stressor.

Table 3 shows the numeric criteria applied by the state of Utah to class 3A waters for total phosphorus. The lower segment of the Little Bear is also listed for hydro modification as a result of some channel straightening practices that occurred in the past. Due to the channel straightening many of the streambanks are actively eroding and increasing the sediment load of this river segment. Because of the correlation between total suspended solids (TSS), bank stability and hydro modification the criteria for TSS is also shown in table 3.

Table 3 - State water quality pollution indicator values for parameters evaluated in the TMDL (also included is numeric criteria for total suspended solids for discussion purposes in this TMDL).

PARAMETER	**Recreation & Aesthetics**		**Aquatic Wildlife**			
	(2A)	(2B)	(3A)	(3B)	(3C)	(3D)
<u>POLLUTION INDICATORS (mg/l)</u>						
Total Suspended Solids (mg /l)		90	35	---	---	---
Phosphate (mg P/l)		0.05	0.05		---	---

For additional information see 'Standards Of Quality for Waters Of The State' R317-2, Utah Administrative Code.

As can be seen in table 4 phosphorus exceeds the state criteria at every monitoring site from Avon to the bottom of the watershed at the Mendon Road crossing.

Table 4 - Percent of historic water quality samples which exceeded water quality indicator concentrations from 1976 to 1992. The state considers sites where more than 25 percent of the samples exceed as non-supporting. These cases are in bold.

		Water Quality Indicators	
LOCATION	**DATES**	**# OF**	**TP***
Spring Creek			
487 - Hyrum slough	1992	10	**80**
490 - Mendon xing	1992	9-11	**100**
492 - west of Pelican Pond	1992	11	**100**
494 - US 89 xing	1992	11	**100**
499 - n. of College Ward	1992	1-13	**38**
Little Bear			
576 - above Davenport Crk	1990-92	9-27	8
577 - Davenport abv S. Fork	1990-92	11-26	8
578 - below Porcupine	1976-79,	15-40	18
575 - above conf. w/S. Fork	1990-92	7-23	0
574 - above conf. w/E. Fork	1990-92	8-25	17
570 - west of Avon	1977-92	40-120	**31**
567 - below White Trout farm	1977-92	22-48	**80**
565 - below Hyrum reservoir	1976-92	17-63	**61**
559 - below Wellsville	1992	1-15	**88**
500 - above Logan River	1977-92	45-131	**66**

* *Total Phosphorus is a pollution indicator parameter.*

III. Water Quality Targets/Endpoints

The desired goal for the TMDL is to meet state water quality standards for the designated and beneficial uses of the waterbody. The target endpoint for total phosphorus is to obtain a concentration of 0.05 mg/l in the river. Endpoints identified to achieve the TMDL coincide with the goals and objectives associated with the Little Bear River Hydrologic Unit Area as described below.

Improve the quality of the Little Bear River water to meet state standards for the designated uses by reducing the amount of nonpoint source pollutants entering the Little Bear River.

Endpoints:

1. Install 14 animal waste management systems in critical treatment areas.
2. Reduce nutrient inputs from cropland by 25% by applying irrigation water management and by installing more efficient irrigation systems.
3. Reduce animal waste runoff into LBR by 33,000 tons/year by implementing Conservation Nutrient Management Plans.

Achieve long term stability of stream channels, streambanks and shorelines through out the watershed and restore a quality fishery.

Endpoints:

1. Reduce sediment from streambank erosion by restoring the stability of 10 miles of streambank along the Little Bear River and its tributaries.
2. Install BMPs on 7500 acres designated as critical. (Critical areas were identified in the LBR HUA Plan and were determined using the PSIAC model). BMPs include Proper grazing use, critical area planting, livestock exclusion, range seeding and upland wildlife habitat management).
3 Install vegetative plantings on 35 acres of riparian habitat.
4 Restrict channel access to livestock by providing watering facilities and fencing on 1200 acres of the LBR and tributaries.

IV. TMDL

The TMDL (Table 5) gives reasonable target pollutant loadings, which should lead to improved beneficial uses of the Little Bear River waterbody and is based on the 10-year return time frequency.

TMDLs have been calculated using 10th percentile flows and median flows for comparative purposes. The 10th percentile flow is that flow which is exceeded on average 90% of the time. Current loading (see table 11) may be more representative of truly average conditions because they are not skewed toward months when samples were more easily collected (for example, low flow summer and fall).

Table 5 - Total phosphorus loads for Little Bear River. TMDLs chosen for the Little Bear River are based on median flows (Calculated in the 'Lower Bear River Water Quality Management Plan').

	TMDL (kg/day)** based on 0.05 mg/liter concentration		HISTORIC LOADS (kg/day) *		
	10th Percentile Flow	Median Flow	Median	Minimum	Maximum
Little Bear River					
Above Cutler	**3**	**9**	**24**	**7**	**76**
Above Hyrum	**2**	**6**	**8**	**1**	**44**

Calculated from UDWQ long-term monitoring data (1970 - 1992).
***** Calculated in the 'Lower Bear River Water Quality Management Plan'.***

The TMDL sets the load for the Little Bear River in kg/day however, it should be noted that in addition to the daily load the concentration of 0.05 mg/liter should not be exceeded.

There is a strong linkage between total phosphorus and TSS. Many of the management practices associated with the implementation of the TMDL address both the reduction in phosphorus and the increased sediment problems associated with hydro-modification.

V. Significant Sources

Identified Sources of Water Quality Impairments

Based on current water quality data, water quality of the Little Bear River does not meet the standards set by the State of Utah for its 3A designated use classifications. The main pollutants of concern include; total phosphorus (TP), and total suspended solids (TSS). The Little Bear drainage shows signs of water quality deterioration both above and below Hyrum Reservoir. Sediment loads increased in both reaches, entering primarily from nonpoint sources. Nonpoint sources of TP above Hyrum Reservoir are a significant source of nutrient loading resulting in impairment of Hyrum Reservoir.

Sediment

Sheet, rill, and gully erosion on rangeland-due in part to reduced vegetative cover caused by overgrazing from livestock and wildlife (Deer and Elk). Sediment from this source is produced during heavy thunderstorms in late summer and early fall, and during periods of rapid snow melt during the spring months.

Streambanks are unstable at many locations along the Little Bear River and Spring Creek due to damage sustained during extensive spring runoff and from animals trampling banks as they use the stream for drinking water. Pollution associated with this type of damage occurs through out the year, but is more pronounced during spring through fall months.

Stream channel erosion is also a major problem and has an adverse effect on riparian areas by lowering the watertable. As a result there has been a reduction in quality and quantity of vegetation essential for protection of the stream channel and streambanks.

Phosphorus

Phosphorus is adsorbed to sediment particles and therefore by controlling the sediment production decreases in phosphorus will also be realized. Efforts to stabilize the channel and the streambanks are expected to have positive results on phosphorus reduction as sediment loads are decreased.

Point Sources

Below Hyrum Reservoir, Wellsville sewage treatment lagoons contribute in part to the increase in TP loads. Hyrum Reservoir acts as a sink for TSS, and TP, but functioned as a substantial source of dissolved total phosphorus (DTP).

An important part of the water quality regulations of the state is the UPDES program (see table 6). Point sources, which discharge into a waterbody, are required to obtain a State of Utah discharge permit. The state determines the maximum allowable discharges of various pollutants from each source, and establishes a monitoring and reporting program for these different sources.

Table 6 – Summary of point sources that contribute pollutants of concern in the watershed.

DISCHARGER	UPDES #	STORET #	DISCHARGE LOCATION
Wellsville Lagoons	UT0020371	490560	Little Bear River
Trout of Paradise 001	UTG130015	490568	Little Bear River
Trout of Paradise 002	UTG130015	490571	Little Bear River
Northern Utah Manufacturing	UT0024872	490562	Wellsville Creek

VI. TECHNICAL ANALYSIS

Total Maximum Daily Load (TMDL) is a means of evaluating and protecting waters based on mass loads of pollutants to the water bodies, rather than just concentrations of pollutants. Using this approach, all point and nonpoint sources can be evaluated according to their relative contributions, and impacts throughout the entire watershed. Similarly, improvements in water quality can be evaluated in terms of their impacts throughout the drainage. Total maximum daily loads for total phosphorus were established for the Little Bear River and its tributaries in the Lower Bear River Water Quality Management Plan.

Loadings for a given pollutant were calculated by multiplying the concentration of that pollutant by the flow, resulting in units of mass per unit time. In cases with well-defined numeric criteria for a given pollutant, the criteria concentrations can be used. In the case of the Little Bear River drainage, the pollutant of concern is phosphorus and in the lower section of the river hydrologic modification.

The state has assigned a specific concentration for defined indicators of water quality, total phosphorus and total suspended solids. The criterion for phosphorus is 0.05 mg/liter of total phosphorus (TP) and for total suspended sediment is 90 mg/L for 2B designated waters and 35 mg/L for 3A designated waters. Because of the direct linkage to plant production dissolved total phosphorus is more biologically available and thus has a more significant impact on eutrophication problems. It is also less associated with sediments and more tightly associated with animal waste and fertilizer runoff. The concentration of 0.05 mg/liter has been established as an endpoint for this TMDL.

An important component of the TMDL is to calculate flow. Choosing an appropriate flow is difficult for several reasons. Most point sources do not vary much with natural flows and therefore they have a greater impact at low flows. Nonpoint inputs, however, often are greatest during high flow runoff periods. Several approaches were considered, including developing separate TMDLs for the runoff and baseflow periods, and developing a single TMDL based on some annual flow estimate. Of concern with a seasonal approach is that the TMDLs be useable management tools. A seasonal TMDL would require increased monitoring during runoff periods. In addition, the runoff period flows are often the least well defined on the non-gauged streams, so additional uncertainty would be involved in establishing runoff TMDLs.

Table 7 - Summary flows for Little Bear River.

		HISTORIC FLOWS (cfs)				
	SOURCE	MEAN	MEDIAN	MIN	MAX	10TH PERCENTILE
Spring Creek **	**UDWQ**		**26**			
Little Bear River						
Above Cutler	**UDWQ**	**84**	**76**	**36**	**181**	**23**
Above Hyrum	**UDWQ**	**78**	**49**	**21**	**175**	**18**

***** Spring Creek is a tributary of the Little Bear River.***

The flow chosen for development of this TMDL is the median flow. Another approach is to use an average flow. This could result in a TMDL for a waterbody being exceeded on average half the time, although conversely, average conditions over several years should equal the TMDL. Another approach would be to use a reasonable low flow estimate, which would protect the water body under most conditions. Typically, TMDLs established for acutely toxic pollutants use a 7-day, 10-year low flow calculated from the historic flow record for a drainage. This flow is calculated by determining the minimum of consecutive 7-day averages for each year of record, then calculating a 10-year return time frequency for each of those flows. A slightly less conservative approach is to take the 10th percentile flow from the historic record. A summary of historic flows in the Little Bear River basin is presented in Table 7. Also listed are the mean flows for the current monitoring program.

Historic flows for the LBR reach a low when summer irrigation diverts the majority of flow to irrigate crops. High flows occur mainly during spring snowmelt runoff. Median flows are 76 cfs and 49 cfs below and above Hyrum Reservoir respectively.

VII. Margin of Safety and Seasonality

Little Bear River Water Quality Improvements

The Bear River is the first area in the state to have two intensive monitoring cycles completed. The first intensive monitoring cycle began in October of 92 and concluded in September of 93. The second cycle of began in July 98 and concluded in June of 99. The monitoring locations cover the Little Bear River from its headwaters down to Mendon Road just above the confluence with Spring Creek and above Cutler Reservoir.

At the monitoring site located below Hyrum Reservoir. The 92-93 data shows eight exceedences of total phosphorus or exceedences in 61% of the samples. The 98-99 data shows two exceedences for total phosphorus or 18%. The reduction in total phosphorus exceedences from 61% to 18% indicates improvement in this parameter.

The lowest monitoring location on the Little Bear River is the Little Bear River at Mendon Road crossing. The 92-93 data shows exceedences of total suspended solids 71% of the time and total phosphorus exceedences 100% of the time. The data from the 98-99 cycle shows exceedences for total suspended solids 40%, and total phosphorus 60% exceedence. Both total suspended solids and total phosphorus show a significant decrease in exceedences from 92-93 to 98-99.

The reductions in the total phosphorus and total suspended sediment reflect the impact of implementation of BMPs on agricultural lands and streambanks. At the time of the 98-99 survey approximately half of the target endpoints had been implemented. This TMDL anticipates attainment of the TMDL goal from implementation of the animal waste facilities and the streambank restoration practices. The margin of safety associated with this TMDL is the implementation of practices associated with cropland, pasture and range areas. Point source reductions will also add to the margin of safety.

VIII. Allocation of Load Reductions or Management Practices

Each nonpoint source area was evaluated separately and sources of nutrients and sediments were identified. Manure management is a critical issue. Runoff from fields spread with manure during the winter and direct runoff from feedlots are also serious problems. Point sources also contribute substantially to nutrient loading.

The potential for reducing pollutant loading by various remediation activities was evaluated and specific recommendations were made. It was predicted that with a medium to high level of remediation effort in the targeted areas, TP loads can be reduced substantially, and the TMDL could be met in the Little Bear River.

Table 8 synthesizes various practices shown in table 9 and their effectiveness at pollution reduction (both tables 8 & 9 were taken from the Lower Bear River Water Quality Management Plan). These levels of effort are then used in table 12 to determine pollution reduction potential.

Table 8 - Percent reductions in predicting phosphorus loads in this report.

	LEVEL OF EFFORT		
SOURCE	**LOW**	**MEDIUM**	**HIGH**
Nonpoint	40	50	90
Point	50	**	90
Feedlots	50	75	90

*** Calculate load based on a 5-mg/liter effluent standards.*

Table 9 - Literature review of remediation and their effectiveness

Potential Sources of Pollution	Remediation	Percent Reduction	Cost	Impact
Feedlots (manure management)	**Structural**			Reduce runoff of nutrients, fecal coliform and total suspended solids from animal waste into adjacent waterways
	Holding Ponds	50-70%	$25,000	
	Lagoons	75-100%	$25,000-$85,000	
	Bunkers	*	$10,000-$50,000	
	Tanks	*		
	Composting			
	Operational			
	Total animal waste management	*		
	Hook into MWWTF			
Agriculture	**Structural**			These practices reduce soil erosion and therefore, decrease the transport of sediments and associated nutrients (soluble and insoluble) into adjacent waterways.
	Sprinkler Systems			
	Operational			
	conservation tillage	full strip 40-90% *(1)* wide strip 40-60% *(1)* narrow strip 50-95% *(1)*		
	Contour farming	50% max *(1)*		
	Strip Cropping	75% max *(1)*		
	Cover Crops	40-60% *(1)*		
	Terrace	95-98% *(1)*		
	Grade Stabilization	75-90% *(1)*		
	Water Sediment Control	40-60% *(1)*		
	Filter strips (10-25 m width)	35-40% (general) *(2)* 70% (nutrients) *(1)*	0.18-1.92/m^2 *(2)*	
	Nutrient Management			
	Livestock Management			
	Exclusion	*		
	Rest-rotation	*		Reduce streambank erosion, reduce the transport of animal waste and associated pollutants (nutrients, fecal coliform and total suspended solids) into adjacent waterways.
	Mgmt + reveg	groundcover>30% *(1)*		
	Mgmt w/o reveg	groundcover >10% *(1)*		
	Fencing	*	$2.00-$2.50/ft	
	Constructed wetlands	?	$5,000 and up	

Streambank	**Non-structural**				These practices stabilize streambanks and reduce soil and streambank erosion.
	Revegetation				
	Trees	15-50%	$1-$2/ft for willows *(1)*		
	Brush	50-60%	0.18-1.92/m^2 *(2)*		
	Grass	up to 90% *(2)*	$55 and up/acre *(1)*		
	Snag removal and clearing	*	$1/ft *(1)*		
	Structural				
	Flow regulation				
	Drop structures	*	Up to $5,000 based on size, length, etc. Up to $20-placed rock		
	Rock Pools	*	$500/ea.		
	Wire structures				
	Revetments		$12/ft		
	Conifer	** *(1)*	$200-400/ft		
	Rock	** *(1)*			
	Deflectors		$500/ea.		
	Single	75% *(1)*	$400/trough + $?/pump + $2/ft for pipe *(1)*		
	Irrigation management (offsite watering, pipelines)	25-75% *(1)*			
Open Channel	**Meander reconstruction**	** *(1)*	$50/ft *(2)*		Reduce streambank erosion
			Cost per MGD **Construction** *(4)*	**Maintenance** *(4)*	
Wastewater	Hook into MWWTF				Reduce total Phosphorus
	Land treatment option	80-90% *(3)*	$980,000-1,200,000	$44,000-64,000	
	Rapid infiltration	80-90% *(3)*	$34,000-44,000	$25,000-47,000	
	Overland flow	30-60% *(3)*			
	Activated sludge	>90% *(3)*	$160,000-820,000	$10,000-64,000	
	Alum	94% *(3)*	$18,000-48,000	$40,000-55,000	
	Ferric chloride	56-97% *(3)*	$16,000-46,000	$28,000-40,000	
	Primary treatment				
	with mineral addition	60-75% *(3)*			
	without mineral addition	40-70%			
	Secondary treatment trickling filter				
	with mineral addition	85-95% *(3)*			
	without mineral addition	70-92%			
	Activated sludge				
	with mineral addition	85-95% *(3)*			
	without mineral addition	85-95%			

(1) Utah Little Bear River Hydrologic Unit Plan 1992
(2) Water Quality Investigations - Lower Bear River and Hyrum Reservoir; ERI 1991
(3) Process Design Manual fo Phosphorus Removal; 625/1-76-0019
(4) Barker et al. 1989

Using information from Reckhow in table 10 for feedlots and nonpoint sources, and the monitoring data collected during the intensive monitoring period in 1998-99 for point sources, allocations of total phosphorus were determined for the various areas throughout the watershed (table 11). As can be seen in table 11 current loads exceed the TMDL both above Cutler and above Hyrum Reservoirs. The calculated load from the monitoring data was considerably less than the estimated load based on table 10. Therefore only the relative comparison from one source to another was used from table 10 to calculate loads in table 11. Feedlots were identified by the local steering committee as being a major problem the estimated load based on Reckhow's table was applied to 100 acres of feedlots within the watershed for table 11.

Table 10 - A range of phosphorus loading coefficients for different landuse. Rates used in loading calculations compiled from Reckhow et al. 1980.

	TOTAL PHOSPHORUS (KG/ACRE/DAY)		
	LOW	**MEDIUM**	**HIGH**
Nonpoint Source:			
Irrigated agriculture	**0.00100**	**0.00243**	**0.00588**
Nonirrigated agriculture	**0.00011**	**0.000832**	**0.00177**

Open/unknown	0.00011	0.000889	0.00294
Urban	0.00011	0.00122	0.00299
Public lands	0.00011	0.00022	0.00033
Feedlots	0.177	0.277	0.471
Cows (kg/cow/day)	0.0008	0.018	0.032

Table 11 - Allocation of total phosphorus loads to different sources in the Little Bear River drainage.

	AREA (acres)	TOTAL PHOSPHORUS LOADS	
		RATE OF LOADING	
		AVERAGE kg/day	ANNUAL kg/year
Point Source:			
Wellsville Lagoons	N/A	0.53	168.2
Trout of Paradise 001	N/A	2.5	766.2
Trout of Paradise 002	N/A	0.33	115.5
Northern Utah Manufacturing	N/A	no data	no data
Nonpoint Source * :			
Irrigated agriculture	21,024	7.83	2859
Nonirrigated agriculture	13,837	1.76	644
Open/unknown	18,171	2.48	904
Urban	2,443	0.46	167
Public lands	121,923	4.11	1501
Feedlots	100	4.25	1550
TOTAL 1999 Load @ Mendon Road:		22	7818
TOTAL 1999 Load above Hyrum		8.4	3066
TMDL Above Cutler (Target Load):		9	3285
TMDL Above Hyrum(Target Load):		6	2190

** estimated using Table 10.*

By combining tables 8 and 11 a determination of the level of effort needed to obtain the TMDL goal can be seen in table 12. A medium implementation effort (a 50% reduction) will be required to meet the TMDL goal in the watershed above Hyrum Reservoir. Above Cutler Reservoir it will take a medium to high level of implementation (50% to 90% reduction) in order to meet the TMDL. Although the reductions in table 12 are only estimates of the reduced phosphorus load associated with the implementation of best management practices, significant decreases should be realized as more and more practices are implemented. As the implementation of the TMDL progresses, the load reduction and limits will be revisited to evaluate accuracy of the expected results.

Prior to the development of this TMDL, no phosphorus data existed for the Northern Utah Manufacturing point source as seen in tables 11 & 12. Additional phosphorus data will be collected and permits will be modified as needed to incorporate reductions.

TABLE 12 - Potential reduction in phosphorus loads in the Little Bear River given different levels of remediation intensity. Reductions are applied to average loads reported in Table 11.

	TOTAL PHOSPHORUS POTENTIAL LOADS (kg/day)		
	LEVEL OF REMEDIATION EFFORT *		
	LOW	MEDIUM	HIGH
Point Source:			
Wellsville Lagoons	0.32	0.27	0.05
Trout of Paradise 001	1.5	1.25	0.25

Trout of Paradise 002	**0.2**	**0.17**	**.03**
Northern Utah Manufacturing	**no data**	**no data**	**no data**
Nonpoint Source:			
Irrigated agriculture	**4.70**	**3.92**	**0.78**
Nonirrigated agriculture	**1.06**	**0.88**	**0.18**
Open/unknown	**1.49**	**1.24**	**0.25**
Urban	**0.27**	**0.23**	**.0.05**
Public lands	**2.47**	**2.06**	**0.41**
Feedlots	**2.12**	**1.06**	**0.42**
TOTAL above Cutler Reservoir:	**12.43**	**9.65**	**2.14**
TOTAL above Hyrum Reservoir:	**9.94**	**5.5**	**1.64**
TMDL Above Cutler (Target Load):	**9**	**9**	**9**
TMDL Above Hyrum(Target Load):	**6**	**6**	**6**

* *See Table 8 for percent reductions assumed for different levels of remediation effort*

IX. PUBLIC PARTICIPATION

Little Bear River Project staff assist landowners and area decision makers to address water quality concerns throughout the watershed. Through a coordinated resource management planning effort a broad array of partners provide guidance and input into project priorities and activities.

The main audience for the project is the LBR agriculture landowners. Efforts are also made to educate local community groups and the youth. Public awareness and support of the Little Bear River Water Quality Project is a major area of emphasis.

Impacts/Accomplishments

- Since its inception, the Little Bear River Project has assisted over 90 landowners to install "Best Management Practices" to address water quality concerns throughout the watershed.
- Volunteer effort from community groups has resulted in over 3000 hours of donated labor.
- Better containment and application of approximately 30,500 tons of manure produced by 2900 animal units and applied on over 1677 acres.

- Cache County has received the Governor's Award, for the most outstanding water quality programs in the state, 3 times in the last 9 years largely due to the Little Bear River Project.

Little Bear River HUA Partners

U.S. Department of Agriculture
NRCS, CSREES, FSA
U.S. Department of Interior
USFWS, USACE
Utah Department of Environmental Quality
Division of Water Quality
Utah Department of Natural Resources
Wildlife Resources, DFFSL,
Water Rights, Water Resources
Utah Department of Agriculture & Food
Environmental Quality Section
Blacksmith Fork Soil Conservation

Bear River RC&D
South Cache Freshman Center
U.S. Environmental Protection Agency
Boy Scouts of America
Audubon Society
South Cache Middle School
Utah State University
Spring Creek Middle School
Cache Society of Fisheries/Cache Valley Anglers
Little Bear Water Users Association
Eco Systems Research Institute
Utah Association of Conservation Districts